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F2P

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(54) Pipe Replacement

(57) An existing pipe 11, for example a gas main, is fractured by moving through it a mole 10 including a reciprocable pneumatic hammer 13 which tows a new pipe 31. The hammer drives the mole and moves plunger 20 to move outwards pivoted elements 28 in head 22 which fracture the pipe 11. Rollers may also engage the pipe. Grout may be supplied through passage 53 to the exterior of the new pipe. A valve may be included in the supply line to the hammer and may be closed to build up pressure and then opened to produce extra forward impact if the mole is stuck.

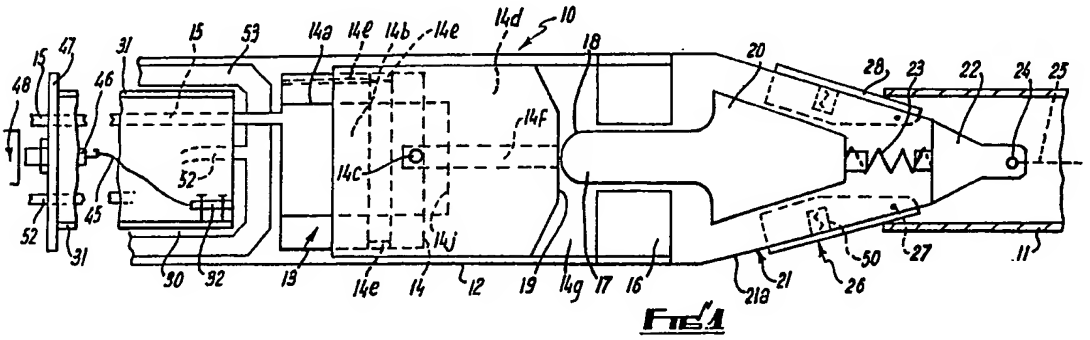

FIG.1

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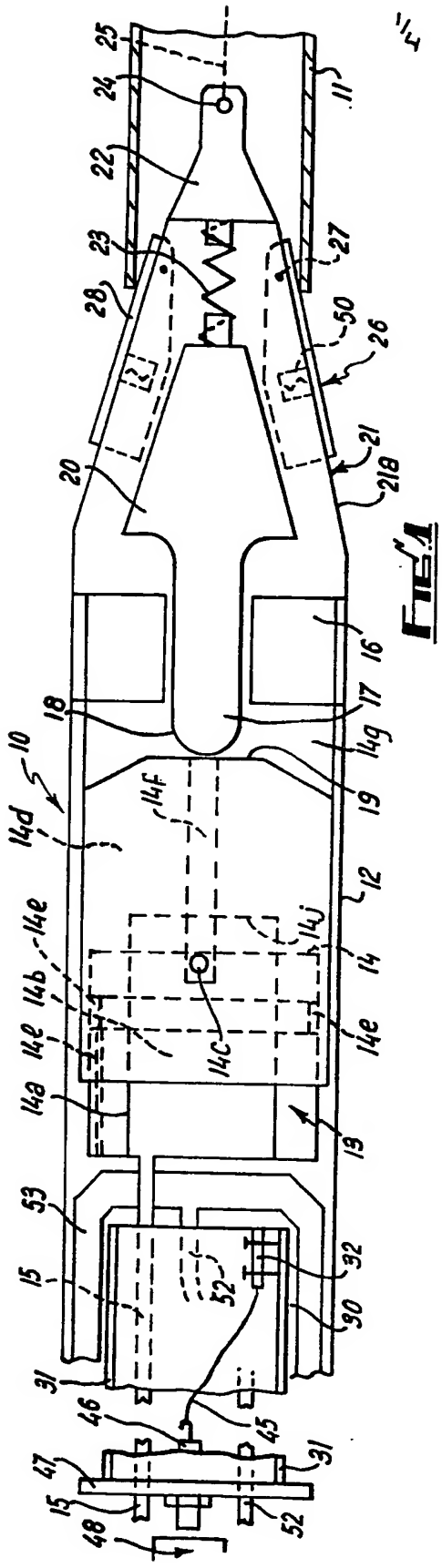

FIG.1

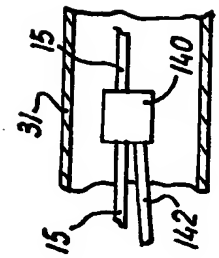

FIG.11

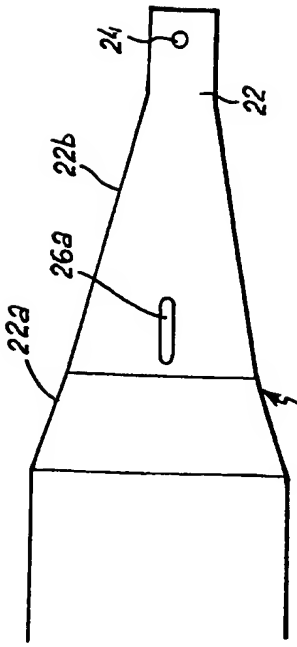

FIG.3

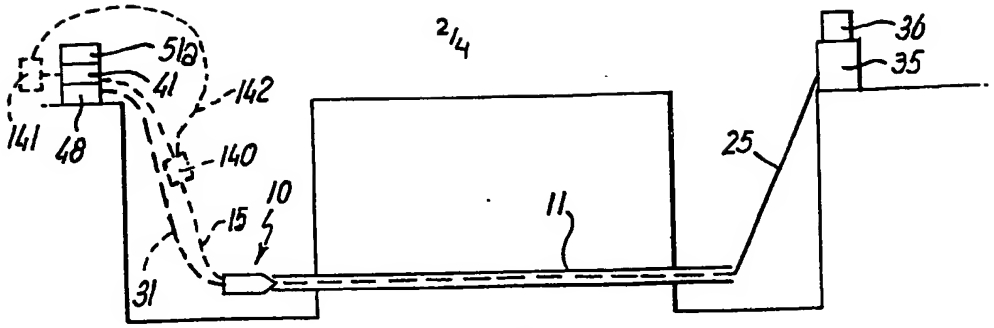

FIG.2

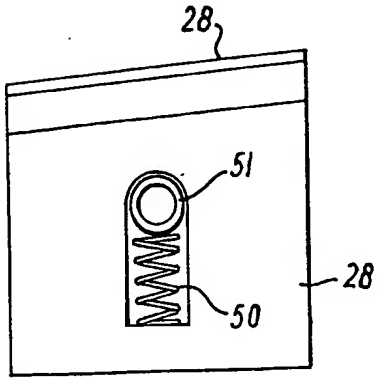

FIG.6

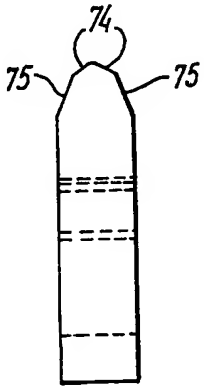

FIG.7

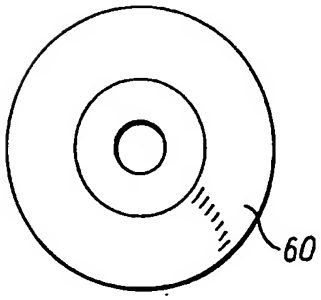

FIG.8

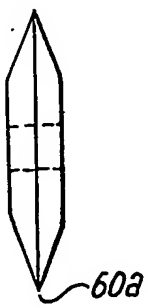

FIG.9

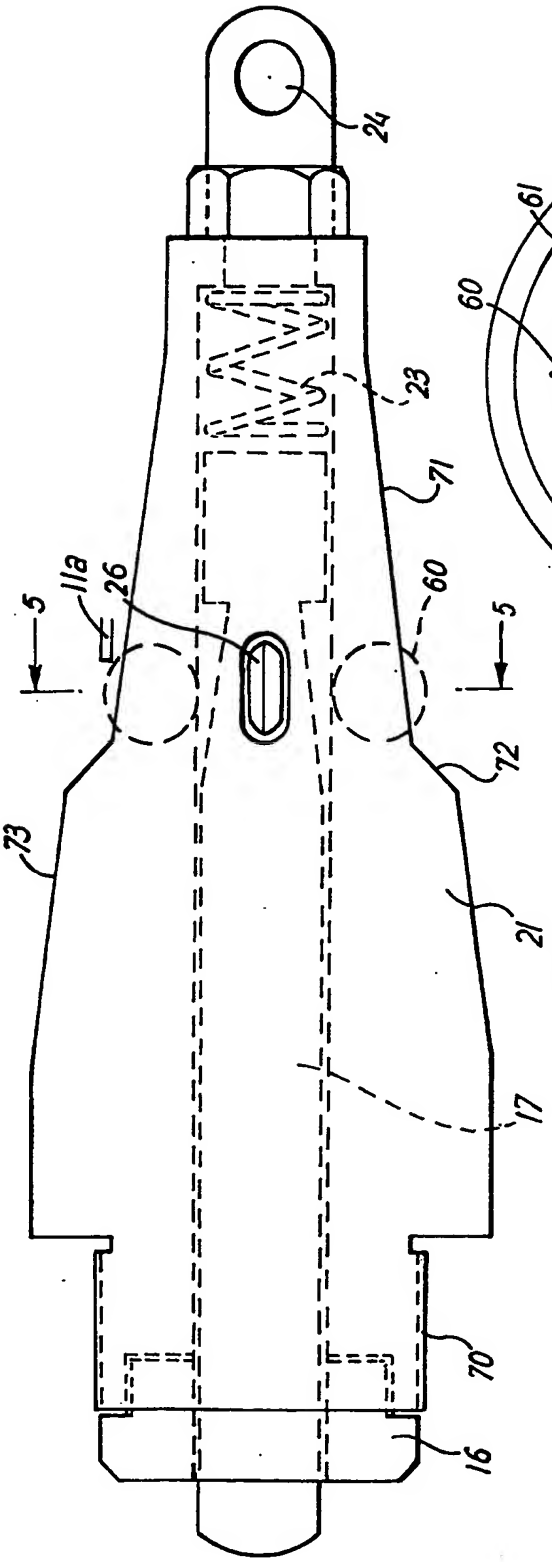

Fig 4

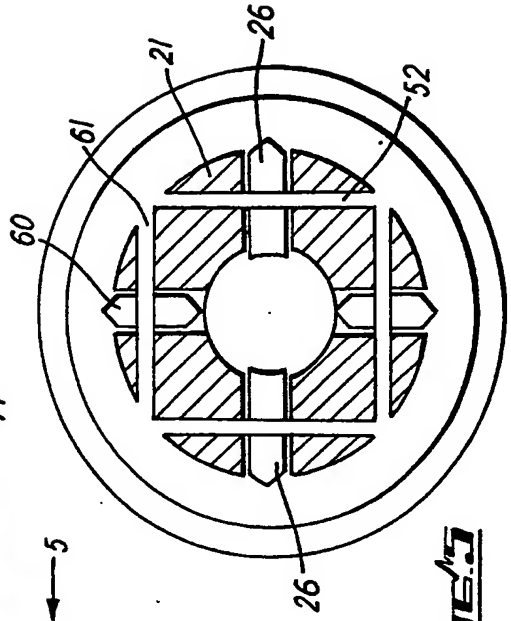

Fig 5

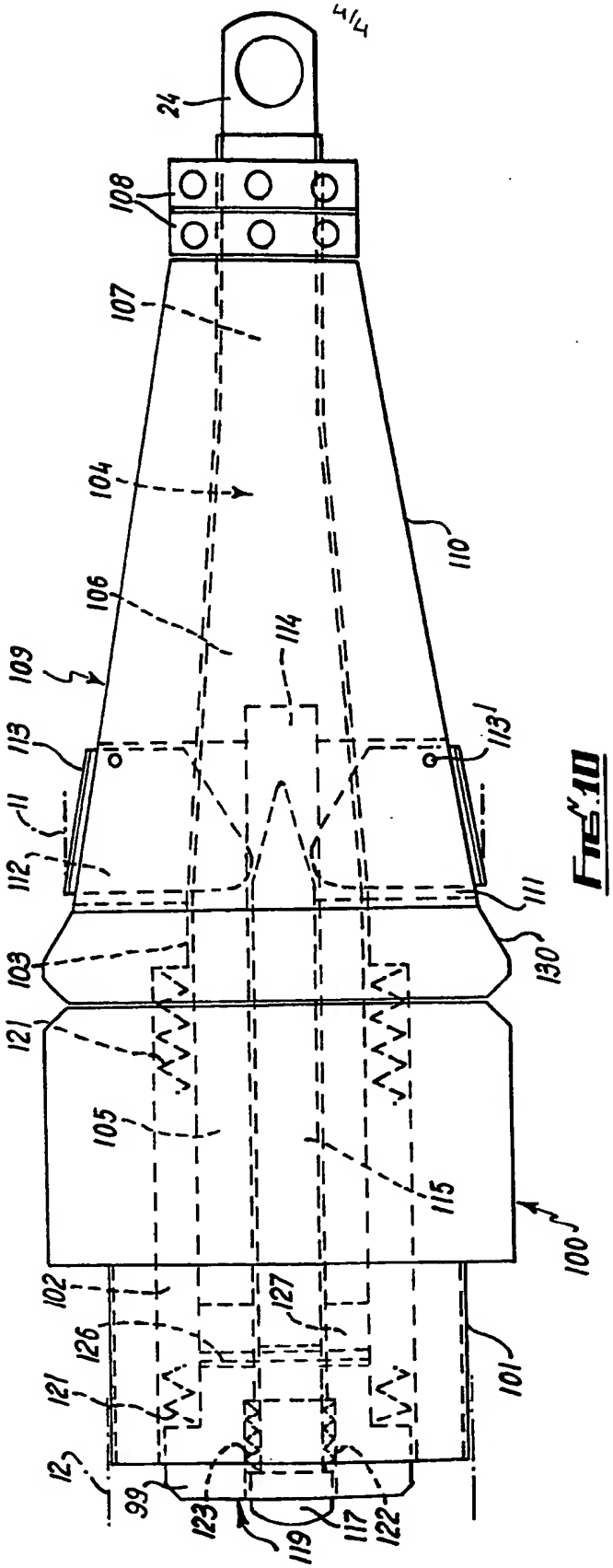
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Fig. 10

SPECIFICATION

Improvements in or Relating to Methods and Apparatus for Pipe Replacement

This invention relates to methods and apparatus for pipe replacement.

It is known to replace a gas main by moving a mole along the main, the mole fracturing the main and towing with it a new main or a liner for the existing main, the liner to act as a sleeve for the new main. Such a mole may include blades movable outwardly to fracture the existing main. The blades are moved outwards by pistons supplied with hydraulic fluid. The mole is pulled by a winch and driven by a pneumatically actuated hammer.

From one aspect the invention provides a method comprising moving a mole having at least one outwardly movable element through an existing pipe, and moving the element outwardly to fracture the pipe using the means which moves the mole. The method may comprise moving a new pipe into the fractured pipe whilst fracturing the existing pipe. Grout may be fed to the exterior of the new pipe whilst the new pipe is moved into the fractured pipe.

The new pipe may be a replacement pipe (which may be an outer sleeve with an inner pipe) or an outer sleeve for a replacement pipe. The replacement pipe is subsequently fed into the sleeve.

The mole or new pipe may be moved in steps.

From another aspect the invention provides apparatus for use in replacing an existing pipe comprising a mole for movement along an existing pipe, the mole including at least one outwardly movable element for engaging and fracturing the pipe, and means operative to move the mole forwards and the element outwards.

The operative means may comprise a pneumatically operable hammer.

There may be an air supply line for the hammer, a flow control valve in the supply line, and means for opening and closing the flow control valve.

The means for opening and closing may comprise a manually operable valve.

The hammer may include a reciprocable piston adapted to move the or each element outwards on forward movement of the piston. The mole may include a plunger for engaging the or each element, and means biassing the plunger into engagement with the piston.

The mole may include rotatable means, for example disc rollers, engageable with the pipe to fracture the pipe.

The mole may be adapted to tow a new pipe.

Means movable with the mole may be provided for supplying grout to the exterior of the new pipe. The means movable with the mole may comprise means for directing grout rearwards to the exterior of a new pipe towed by the mole.

The new pipe may be the replacement pipe or an outer sleeve for a replacement pipe.

The new pipe may be a sleeve and inner pipe.

The mole may comprise a first piston for moving the element(s) outwards and a second piston for moving the element(s) forwards. The first and second pistons may be biassed towards the hammer.

The invention may be performed in various ways and three specific embodiments with possible modifications will now be described by way of example with reference to the accompanying somewhat diagrammatic drawings, in which:

Fig. 1 is a side view of a mole;

Fig. 2 is a side view showing use of the mole;

Fig. 3 is a side view showing modifications;

Fig. 4 is a side view of part of another embodiment;

Fig. 5 is a section on the line 5—5 of Fig. 4;

Fig. 6 is a side view of a fin;

Fig. 7 is an end view of the fin of Fig. 6;

Fig. 8 is a side view of a roller;

Fig. 9 is an end view of the roller of Fig. 8;

Fig. 10 is a side view of part of a further embodiment; and

Fig. 11 shows a modification.

The mole 10 (Fig. 1) is used in replacing an existing duct, pipe or main 11, for example a cast iron gas main buried underground. The mole 10 comprises a circular cross-section hollow body 12 in which is centrally slidably mounted a pneumatically operable hammer device 13 including a reciprocable piston 14. The hammer device is generally conventional and is continuously supplied with compressed air through line 15 and operates intermittently.

One example broadly described the percussion piston 14 can slide on cylindrical element or control sleeve 14a and includes hollow rear part 14b having front face 14j which receives the air pressure. The piston 14 includes transverse bore 14c which communicates with axial passage 14f in the outer surface of piston 14. The sleeve 14a has an annular recess 14e in its outer surface communicating with axial passage 14h leading to exhaust. In a start position, bore 14c communicates with recess 14e also. On initial forward movement, air pressure in part 14b urges the piston 14 forwards, air from the space 14g ahead of the piston 14 passing to exhaust via passage 14f, bore 14c, recess 14e and passage 14h. Halfway in the forward movement of the piston 14 towards striker 17 slidable in internal support 16 the bore 14c ceases to communicate with recess 14e. Thus pressure builds up in space 14g and as this acts on the front face 19 of the piston 14, which is of greater area than the face 14j, the piston 14 is urged rearwards back to the start position by the air pressure. Before the start position is again reached, communication is again established between bore 14c, passage 14f and recess 14e thus to exhaust space 14g and ready the hammer for the next forward stroke. The hammer device 13 normally includes a striker cone which is biassed by a spring towards the piston 14 so that when the striker is hit by the piston 14 the striker moves forwards and the

device is urged forwards through the spring means. On impact bore 14c communicates with part 14b. The piston 14 recoils to the start or rear position as above. In some cases an intermediate piston is located between piston 14 and the striker. Further details are not considered necessary as the hammer and reciprocating piston are known to the skilled man and may take various forms.

However, in the present case the plunger or striker 17 has a curved face 18 engaging the flat centre portion of piston end 19 of the piston and the plunger 17 has a generally frusto-conical head 20 which in the position shown is partly within the tapered front head 21 of the mole body 12. The front end 22 of the body 12 is solid and a helical compression spring 23 extends between the head 22 and the flat front face of the plunger head 20 to provide the return bias for the plunger 17 to assist the recoil of the piston 14.

The body head 22 is formed with a tow eye 24 connectable to a winch cable 25.

Located in axial slots in the front body head 21 are a plurality of equi-angularly spaced fins 26 and each pivoted to the head 21 near their forward ends at 27. There are preferably three fins 26 but it is considered that there could be only one.

Outer, cutting, edges 28 of the fins 26 are normally slightly proud of the tapered outer surface 21a of head portion 21 as shown.

The rear end of the body 12 includes a cup-shaped member 30 in which may be clamped the leading end of a length of plastics pipe 31 which may be part of a new main, or an outer protective sheath for a new main. The cup-shaped member 30 also supports a clamp 32 for clamping to one end of a cable 45 connected at its other end to a fastening 46 fixed to plate 47 which, by rotating threaded winch element 48, is drawn against the end of the pipe 31 and the cable 45 is tightened. The pipe 31 is thus clamped in position between element 30 and annular plate 47.

In use, the ground (Fig. 2) is dug out to expose the ends of the length 11 of main to be replaced, and the mole 10 is engaged in the mouth of one exposed end, the winch cable 25 having previously been passed through the pipe 11 from the other exposed end and engaged in the tow eye 24. The cable 25 is connected to a winch 35 driven by a motor 36.

The new liner length 31 is clamped to the rear end of the mole as explained and air under pressure is supplied from compressor 41 to conduit 15. The winch motor 36 and the compressor 41 are started and the combined effects of the winch pulling the mole 10 and the reciprocation of the piston 14, urge the mole 10 forwards along the existing main 11.

On a forward movement of the piston 14 relative to the body 12, the plunger 20 is urged forwards against the effect of the spring 23 and hits the inner faces 42 of the fins 26 causing them to pivot outwards and fracture the main 11 or a part thereof. Impact of the plunger 20 on striker 17 also urges the mole forwards, after the outward movement of the pivoting fins or wedges 26, via spring 23 or during the movement.

Thus each step-by-step forward movement of the piston urges the fins 26 outwards, and the compressed air in effect operates both the piston 14, and thus the mole, and the fins 26.

The forward speed of the mole may for example be 1 metre per minute; the inside diameter of main 11 may be 10.2 cm (4 inches); the outside diameter of pipe or liner 31 may be 12.6 cm. If the pipe 31 is a sleeve for a new main, the outside diameter of pipe 31 may be 14 cm. However, these dimensions can take other values.

Generally the internal diameter of the new main will be at least equal to the internal diameter of the old main 11, and preferably greater.

If the pipe 31 is to be an external sleeve, the new main may be pushed through the sleeve when the sleeve is fully in position. Alternatively the pipe 31 may comprise a combined plastics outer sleeve and an inner plastics main, drawn in together by the mole.

Side connections to the new main can be made in the usual way.

Sufficient clearance in the fractured main is maintained by the apparatus to allow the movement of the new main into the fractured main whilst the existing main is being fractured.

In a modification the fins 26 are biassed outwardly by springs 50 connected between a side of a respective fin and an abutment on the front head 21.

Preferably the space around the exterior surface of the pipe or liner/sleeve 31 is provided with grouting material as the mole 10 moves forwards. Thus grout under pressure may be supplied from source 51a through conduit 52 to annular rearwardly facing grout outlet 53 outside member 30 so that grout is discharged rearwards over the pipe 31. The grout will set and resist movement of the newly installed pipe and tend to resist damage to pipe 31 by pieces of the fractured main 11. A suitable grout is a mixture of water, cement and pulverized fly ash. The conduits 15, 52 are within pipe 31.

In the described arrangement the reciprocating piston itself effects outward movement of the fins or blades 26 which is simpler than having a separate hydraulic piston and associated fluid supply. Moreover with the described arrangement the blades are repeatedly moved outwards which assists in fracturing the existing main.

In a modified arrangement shown in Fig. 3 the head 22 is slightly altered in shape having an inner tapered portion 22a and a forward, less tapered, portion 22b with the slots 26a for the fins 26 being immediately forwards of the inner portion 22a.

Figures 4 to 9 show a preferred arrangement having both two diametrically opposed disc rollers 60 mounted on pins 61 and two orthogonal fins 26. The rollers 60 have peripheral scoring edges 60a. The fins include a recess housing spring 50 in this case engaged between the base of the

recess and a bush 51 for receipt of pin 52, mounted in the plunger 17.

The mole head 21 is generally solid and at its rear has external threaded portion 70 by which it is removably mounted in the mole. The support 16 is of slighlty smaller diameter on the rear of the head 21 to fit in the hollow body 12 and is integral with the head 21 or otherwise operatively secured thereto. The head 21 external surface has an initial axial portion leading to a tapered portion 71 at a guide angle (e.g. 15°) to the central axis, leading to another tapered portion 72 at a deflector angle (e.g. 45°) leading to a third tapered portion 73 at a compression angle (e.g. 15°). The working sides of the fins or chisels 26 Fig. 7 may have first portions 74 at a breaking angle (e.g. 45°) to the radial plane leading to second portions 75 at a strength angle (e.g. 15°). The end of the pipe 11 is indicated at 11a in Fig. 4.

A particularly preferred arrangement is shown in Fig. 10. As in Fig. 4, a head 100 has an external thread 101 by which it is secured in the end of the hammer 13, so that the head 100 acts as the striker support. The hollow body 12 is shown dotted. The head 100 has a through bore 102 leading to narrower portion 103 in head 109. A driving head 104 has an inner portion 105 of uniform cross-section provided with an inner enlarged head 99; an intermediate tapered portion 106 and a front portion 107 of uniform cross-section, the front part of which is threaded to receive lock nuts 108. An outer part 109 of the driving head is an interference fit on the intermediate portion 106, and a rear part of the front portion 107. In the retracted position shown, the outer part 109 abuts the front end of the head 100 and has an external surface which diverges from the rear face, then is of uniform section, then tapers inwards at a first angle, then has a front portion 110 which tapers inwards at a second, smaller angle. One or more pairs of diametrically opposed slots 111 are formed in the rear part of the front portion 110 and receive flat chisels 112 having outer scoring edges 113 which taper inwards with the portion 110 and are slightly proud thereof.

The chisels are pivoted in the head at 113'. The inner edges of the chisels extend into a central blind bore 114 extending through the inner portion 105 and into the intermediate portion 106. A piston 115 is slidable in the bore 114 and has a tapered leading end portion 116. The inner face 117 of the piston 115 is convexly curved, for engagement with the hammer piston 19, and is in an enlarged bore in a secondary piston 119 constituted by the driving head 104. A helical spring 121 in bore 102 biasses the piston 119 (head 104) towards the pneumatic hammer and a helical spring 122 in a bore 123 in the piston 119 biasses the piston 115 towards the hammer. In one arrangement, the piston 115 extends inwardly 0.65 cm from the inner (rear) end of the piston 119 and the piston 119 extends inwardly 1.27 cm from the inner end of the head 100, 101. A transverse bar 126 is fixed to the piston 115 and is movable in transverse slots 127 in the piston 119 and limits the return or rearward movement of the piston 115 by engaging the piston 119.

In use, forward movement of hammer piston 19 moves the piston 119 which pivots the chisels 112 outwards to score the inner surface of the pipe 11; further forward movement of the piston 19 moves the piston 119 and the piston 115 together to burst the pipe 11; this may be assisted by winch 35.

Forward movement of the driving head 104 and the outward movement of the chisels 112 is effected by the hammer. The bursting of the pipe 11 may be assisted by the face 130. Forward movement of the pistons 115, 119 is cushioned by the springs 121, 122.

In an important modification, a flow-control valve 140 Fig. 2 is incorporated in the air supply line 15. The valve 140 may be closed and when sufficient air pressure has built up behind it, opened so that the pressure supplied to the hammer, particularly on the initial stroke, is sufficient to overcome the resistance, for example inertial, to movement of the mole. The valve 140 can be included at a convenient place in the air line 15, conveniently about 10 feet (300 cm) from the mole. The valve 140 in one arrangement is supplied with air to open the valve 140 via a manually operable flow-control valve 141 itself receiving air from the compressor 41 and supplying valve 140 via secondary line 142. Thus, for example, if the mole is stuck, for example due to a long length of pipe 11, the valve 140 can be closed by closing valve 141 and then, when pressure has built up in line 15 upstream of valve 140, opened by opening valve 141 to give a hard push to the mole. The arrangement is shown schematically in Fig. 2; in the present case the valve 140 is inside the pipe length 31 see Fig. 11 and the lines 142 and 15 extend through annuiar plate 47. This arrangement allows a smaller compressor to be used.

The invention is not restricted to replacing gas mains but can be used to replace other pipes or conduits for example water mains or certain sewers.

The valve 140 could be remotely operated through electrical means or hydraulic or other means, instead of pneumatic means.

The hammer could strike support 16.

CLAIMS

1. A method comprising moving a mole having at least one outwardly movable element through an existing pipe, and moving the element outwardly to fracture the pipe using the means which moves the mole.

2. A method as claimed in Claim 1, comprising moving a new pipe into the fractured pipe whilst fracturing the existing pipe.

3. A method as claimed in Claim 1 or Claim 2, in which the mole is moved in steps.

4. A method as claimed in Claim 2, including

supplying grout to the exterior of the new pipe whilst moving the mole.

5. A method as claimed in Claim 1 and substantially as herein before described.

6. Apparatus for use in replacing an existing pipe comprising a mole for movement along an existing pipe, the mole including at least one outwardly movable element for engaging and fracturing the pipe, and means operative to move the mole forwards and the element outwards.

7. Apparatus as claimed in Claim 6, in which the operating means comprises a pneumatically operable hammer.

8. Apparatus as claimed in Claim 7, including an air supply line for the hammer, a flow control valve in the supply line, and means for opening and closing the flow control valve.

9. Apparatus as claimed in Claim 8, in which the means for opening and closing comprises a manually operable valve.

10. Apparatus as claimed in Claim 7 or Claim 8 or Claim 9, in which the hammer includes a reciprocable piston adapted to move the or each element outwards on forward movement of the piston.

11. Apparatus as claimed in Claim 10, in which the mole comprises a plunger for engaging the or each element, and means biassing the plunger into engagement with the piston.

12. Apparatus as claimed in any of Claims 6 to 11, in which the mole comprises rotatable means engageable with the pipe to fracture the pipe.

13. Apparatus as claimed in Claim 12, in which the rotatable means comprises disc rollers.

14. Apparatus as claimed in any of Claims 6 to 13, in which the mole is adapted to tow a new pipe.

15. Apparatus as claimed in Claim 14, including means movable with the mole for supplying grout to the exterior of the new pipe.

16. Apparatus as claimed in Claim 15, in which the means movable with the mole comprises means for directing grout rearwards to the exterior of a new pipe towed by the mole.

17. Apparatus for use in replacing an existing pipe substantially as herein before described with reference to and as shown in Fig. 1, or Fig. 3, or Figs. 4 to 9, or Fig. 10 of the accompanying drawings.

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